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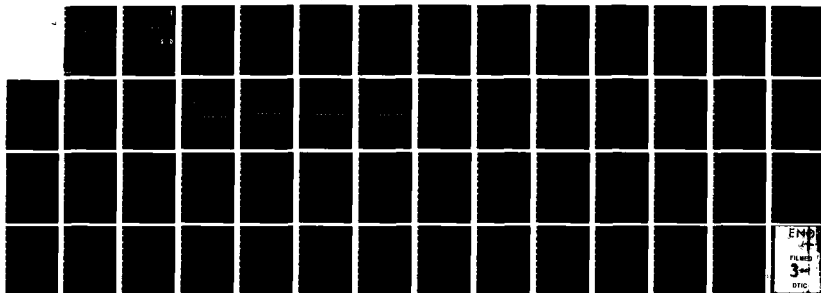
TRIAGE AND INJURY SEVERITY SCORING SYSTEMS CONFERENCE
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TRIAGE AND INJURY SEVERITY SCORING SYSTEMS CONFERENCE

FINAL REPORT

Howard R. Champion, F.R.C.S., F.A.C.S.

Frank Lewis, M.D., F.A.C.S.

February 1984

Supported by

US ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
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The Washington Hospital Center
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <p>Report summarizes the conference on Injury Severity Scoring and Triage that was held in Washington, D.C. on September 26 - 28, 1983. The purpose of the conference was to discuss the status of injury scoring indices and define their applicability to field or secondary triage in civilian and military environments.</p> <p>The conference was attended by invited physicians experienced in emergency medicine, as well as scientists in the field of public health, epidemiology,</p>											

20. (continued)

and biostatistics.

The objectives of the conference were to:

- (1) Identify existing civilian and military triage rules.
- (2) Identify existing civilian and military resources and triage objectives.
- (3) Summarize application of severity scores to triage.
- (4) Discuss existing stratification of care capabilities in military and civilian medicine.
- (5) Develop triage guidelines for civilian and military use.
- (6) Develop methods of measuring the efficacy of triage.
- (7) Identify paramedic interventions that need focused scientific research.

The report includes proceedings of the conference and summaries of conclusions and recommendations.

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INTRODUCTION

A conference on Injury Severity Scoring and Triage was held in Washington, D.C. on September 26 - 28, 1983. The purpose of the conference was to discuss the status of injury scoring indices and define their applicability to field or secondary triage in civilian and military environments.

The conference was attended by invited physicians experienced in emergency medicine, trauma surgery, and military medicine, as well as scientists in the field of public health, epidemiology, and biostatistics.

The objectives of the conference were to:

- (1) Identify existing civilian and military triage rules.
- (2) Identify existing civilian and military resources and triage objectives.
- (3) Summarize application of severity scores to triage.
- (4) Discuss existing stratification of care capabilities in military and civilian medicine.
- (5) Develop triage guidelines for civilian and military use.
- (6) Develop methods of measuring the efficacy of triage.
- (7) Identify paramedic interventions that need focused scientific research.

RECOMMENDATIONS

The following are the conclusions and recommendations of the conference. For a summary of the discussions which led to these results, please refer to the conference proceedings.

I. The Trauma Score is a well-defined measure of physiologic severity that can be used for triage and evaluation of care purposes. In applying the Trauma Score to triage decisions, mechanism of injury and anatomical factors should be taken into consideration. When used in such a manner, the Trauma Score can exclude 75% of patients with minor injuries and can triage 85-90% of the moderate and severely injured patients. It was recommended that research be conducted into the component parts of the Trauma Score to formulate the cardio-respiratory and central nervous system variables separately.

II. Mechanism of injury and anatomical factors should be among the other factors considered in determining where a patient should be triaged. Patients with the following should be treated at a Trauma Center:

A. Mechanism of Injury Factors:

1. Evidence of high energy dissipation or rapid deceleration; or
2. Falls of 15 feet or greater; or
3. Evidence that the patient was in a hostile environment when injured (e.g., hot desert, icy cold water); or
4. Motor vehicle accident with:
 - a. extrication time longer than 20 minutes
 - b. passenger space invaded by 1 foot or more
 - c. ejection
 - d. death of other passengers
 - e. child less than 12 years of age struck by a car

B. Any of these anatomic factors:

1. penetrating trauma to head, neck, torso, or groin to mid-thigh.
2. major amputation above the ankle or wrist
3. major burns in association with trauma (greater than 20% second or third degree)
4. paralysis

III. Use of specific pre-hospital skills and resources could improve salvageability. Those include:

1. Basic skills, especially immobilization and splinting
2. Expeditious transport to definitive care. In an urban environment, this should be less than 20 minutes from EMS system notification.
3. Immediate notification to the receiving facility.

4. Proper use of endotracheal intubation increases potential salvageability. Proper insertion, however, is difficult to master and long term usage must be monitored.
5. Esophageal obturator airway appears not to work.
6. IVs and MAST are currently widely used. There is no convincing data that they are useful, and their use is also questionable considering the time necessary to use them. As these two items are the standard of care in most trauma systems, however, they probably should be retained.
 - a. IVs - MICPs paramedics should be able to start large bore IVs and should be able to infuse volume amounts.
 - b. MAST - MAST should be used upon physician order and with an adequate triage and transport system.
7. Certain pre-hospital treatments have not yet been proven effective and can be dangerous if inappropriately used, specifically:
 - a. Chest decompression;
 - b. Cricothyroidotomy;

IV. Anatomic severity indices, such as the Abbreviated Injury Scale and the Injury Severity Score are not useful in the pre-hospital phase of care. They do have value, however, in retrospective studies where precise determination of anatomical derangement is available. These indices may also be used in conjunction with the Trauma Score to identify "outliers", i.e., those patients whose outcomes are unexpected, given their severity of injury. Data collection of these and other indices should be made part of quality assurance efforts

V. The following were identified as clear research questions which should receive increased attention:

1. The effect of comorbid factors on outcome.
2. The effect of age on the Trauma Score.
3. Trauma resulting from an explosion.
4. Specific pre-hospital interventions need research to establish their usefulness and to justify their continued application in the field. These are:
 - o endotracheal intubation
 - o esophageal obturator airway
 - o intravenous infusion of fluids
 - o military anti-shock trousers
 - o chest decompression
 - o cricothyroidotomy

The conference sessions were of several different types: formal presentations by invited guests; large group discussions of specific topics led by invited guests; small group discussion of specific questions by group leaders; and large group consensus building sessions.

A summary of the conference proceedings follows.

Field and Emergency Department Use of Injury Severity Scores

**John Morris, M.D.
Frank Lewis, M.D.
San Francisco General Hospital**

The purpose of this study was: (1) to determine whether the field Trauma Score performed by the paramedic was comparable to the Trauma Score performed by a senior surgical resident in the Emergency Room under optimal conditions; and, if so, (2) can field Trauma Score be used for triage? The study was conducted in San Francisco, a city of 48 square-miles, with a population of 700,000. San Francisco General Hospital is a regional Trauma Center that receives all major trauma in the area. The transport times for trauma patients are relatively short. Twenty percent (20%) of the patients reach the hospital in 20 minutes or less; 75% of the patients reach the hospital in 40 minutes or less; and 90% of the patients arrive within the "golden hour".

This study focused on a set of 454 patients for whom Trauma Score (TS) variables were gathered at the scene by the paramedic, with the actual Trauma Scores being calculated later (known as Trauma Score I); and for whom Trauma Scores were calculated upon admission by a senior surgical resident (known as Trauma Score II). The senior surgical residents were paid to complete Trauma Scores on each patient, which resulted in 99.6% of the patients having both TSs calculated.

The first question addressed by the study was whether the two scores were comparable. The researchers determined that a score variation of plus or minus one point was an acceptable observer variation. The study focused on patients whose two scores differed by more than one point. There were 41 patients whose Trauma Scores improved between Trauma Score I (TS I) and Trauma Score II (TS II). There were 28 patients (6%) whose Trauma Score deteriorated.

Also examined was whether the deteriorations were actual deteriorations or were they due to observer changes. In the subset of 28 patients whose scores deteriorated, the mortality was approximately 30%, or three times the average. This group had eight times the average number of head injuries of the group as a whole, and also a higher rate of penetrating injuries. The researchers concluded that the deterioration was not due to variability, but rather to actual physiological change.

The researchers examined the frequency of the distribution of the Trauma Score in the population. Approximately 75% of the patients had a Trauma Score of 15 or 16 and 25% had a score of 14 or less. The data showed that as survival decreased, the Trauma Score decreased.

John Morris, M.D./Cont'd
San Francisco General

The researchers then examined whether survivability could be based on TS I and TS II. To address this question, the probabilities of survival were calculated, maintaining age and Injury Severity Score for each patient as a constant. Using TS I, a total of 409 patients were predicted to survive who actually survived. Using TS II, 410 patients were predicted to survive who actually survived. Prediction of deaths was similar: 28 were predicted to die using TS I, and 29 were predicted to die using TS II.

Finally, the researchers examined whether there were any "sick" patients who had a Trauma Score of 15 or 16. "Sick" was defined as Injury Severity Score of 20 or higher. Results showed that about 10 of the patients fit into this category. This group was examined in detail with the following results:

- I. 30 patients had ISS of 20 - 29. - In this group, there were two patients with stab wounds to the heart, both of whom developed pericardial tamponade and required emergency thoracotomy.
- II. 3 patients had ISS of 30 - 39.
- III. 6 patients had ISS of 40 - 49. - In this group, one patient had severe head injury and subsequently died. The remaining five patients had penetrating trauma to the thorax and abdomen.

The researchers concluded that the Trauma Score could be used to accurately identify a subgroup of patients with a Trauma Score of 14 or less, which represented 25% of their admission population and encompassed 95% of their deaths. The Trauma Score, as assessed in the field, did not detect 10% of the patients with significant injury.

COMPARATIVE DATA ON INJURY SEVERITY SCORES

Larry Schuman, Ph.D
University of Pittsburgh

This study correlated several physiological indices with a subjective consensus of severity made by a panel of physicians. The researchers developed algorithms representing different conditions the paramedics would see in the field. Associated with those algorithms was a scoring system that evaluated the compliance between the pre-hospital care given and what the standards should be. To go along with the algorithms, a number of severity indices were evaluated against an assessment of severity by a panel of physicians. The researchers were particularly interested in determining how well the indices computerized, because they had a large pre-hospital data base that included vital signs, times the signs were taken, times the aid was given, etc.

The evaluation of the severity scoring systems was based on the Woodstock criteria: outcome validity, construct validity, face validity, inter-rater reliability, data availability, separation of severity from quality of care, and simplicity of use. The researchers did not examine the correlation of the severity indices with outcome because they believed that the quality of care was an intervening factor.

The study was based on a sample of 840 cases. A panel of six physicians rated each case on severity. Inter-correlations among six physician raters ranged from .72 to .85.

Among the severity indices evaluated were the following:

1. Trauma Score upon paramedic arrival in the field
2. Trauma Score worst case
3. Trauma Score upon arrival at ED
4. the Illness-Injury Severity Index by Bever and Veneker
5. The Injury Severity Score

The ISS had the disadvantage that it could not be computerized. To determine the ISS, the Nurse Research Assistant went through a sample of 238 of 319 cases to determine and record the ISS.

The cases were categorized into four groups: life-threats, severe, moderate, minor. The researchers compared how the cases were classified by the indices and by the physicians. All the indices did very well in terms of the minor/moderate and did about the same in terms of the severe cases. For life-threats cases, however, the percent correct ranged from a high of 86% to a low of 19%.

Influence of Comorbid Factors on Injury Severity

Douglas P. Wagner, Ph.D.
George Washington University Hospital

The researchers are in the process of conducting a multi-hospital study. The sampling frame is the Intensive Care Units in 14 major medical centers in the United States, including: George Washington, Massachusetts General, Stanford, Hopkins, University of Maryland, University of Virginia, University of Wisconsin, St. Francis' Hospital in Tulsa, Oklahoma, University of Georgia's Medical Center in Augusta and two 300-400 bed community hospitals. The study focuses on intensive care unit patients in a mix of medical or surgical Intensive Care Units and medical and surgical ICUs. The study, funded by NCHSR, has not yet been completed. Some preliminary results are presented here.

The purpose of the research is to develop an acute severity of illness measure for patients in the ICUs or shortly before they arrive. The measure is based on sixteen physiologic parameters including respiratory rate, blood pressure, pulse, Glasgow Coma Scale. All the measurements are available from vital signs, blood gas and SMA-12. The measurements are combined with a weighting system (developed from consensus expert opinion) into an acute physiology score which has been shown to be significantly related to survival at ICU and hospital discharge.

A pre-admission categorization scheme is based on a number of definite items, including the New York Heart Association's four-category scale for cardio-vascular symptoms. Similar sets of items are used for respiratory disease, functional status and productivity. Patients are put into four categories: healthy; minimally impacted by chronic disease; moderately impacted by chronic disease; and severely impacted.

There are about 6,000 patients in the study to date. Of this group, approximately 400 (7%) were admitted to the ICU because of trauma. The trauma patients were significantly younger than other ICU patients--73% of 400 trauma patients were less than 45 years of age; 8% were 45-55; 8% were 55-65; 6% were 65-75 years of age; and 3% over 75. Seventy one (71%) of the trauma patients were in the healthy category; 18% were in the 2nd category; 3% were in the third category and 1.5% were in the worst chronic health category. Regarding whether any measure mattered in terms of outcome, when multiple regressions of survival were run, the dominant item that explained outcome was the acute physiologic derangement at ICU admission.

If the characteristics of the subset of 400 trauma patients are no different from the entire sample of 6,000 patients, then age and pre-admission status will be significantly related to outcome, even when the acute physiologic derangement at ICU admission is controlled. The potential similarity, however, is presently unknown.

Preliminary Results from the ACSCOT Major Trauma Outcome Study

Howard R. Champion, M.D.
William J. Sacco, Ph.D.
Washington Hospital Center

The Major Trauma Outcome Study is being conducted to acquire a national data base to further the development of existing methods of measuring injury severity and for determining the national average patient outcome in trauma centers for different levels of trauma severity. This national normative outcome standard would provide participating institutions throughout the country with a "yardstick" against which the outcome of their own patients could be compared and with which they could begin to track their progress in improving patient care. The study began in 1982.

The study is based on a methodology called TRISS. To implement the methodology, patients are characterized by both anatomical (Injury Severity Score) and physiological (Trauma Score) factors and age. The Trauma Score on admission and the Injury Severity Score as determined from completed anatomical diagnoses following surgery or autopsy serve as the characterization of patient severity. Other factors such as cause of injury, disposition, etc., are also collected.

By the end of October 1983, data on over 9,000 patients had been submitted from 48 institutions. The first analysis was carried out on 6,332 patients received from the study's inception through July 15th, 1983. Of this group, 232 were rejected because they did not fall into the patient definitions required by the study. Of the remaining 6,100, 4,365 were blunt injured patients and 1,735 were penetrating injured patients. There were 420 (7%) deaths. For various reasons, certain patients were excluded from the first analysis:

1. Pediatric patients of age 14 or less.
2. Patients with missing Trauma Score variables of incomplete or anomalous diagnoses that could not be clarified to allow for determination of an Injury Severity Score.
3. Patients who died who had not received surgery, autopsy or CT Scan.

These groups will be included in future analyses, but were omitted here to make the first set as free as possible of missing data and other problems. This left 3,138 blunt trauma patients, including 229 deaths (7.3%), and 1,516 penetrating trauma patients, including 123 deaths (8.1%).

Logistic regression analyses were then carried out separately on patients with blunt and penetrating injuries. Additionally, two statistics, Z and M, were determined for each patient category (blunt and penetrating) for each institution. The Z statistic is a measure of the disparity between the institution and the national norm. If a figure greater than +1.96 is given, the result is significantly better than the national average. If a figure of less than -1.96 is given, the result is significantly worse result than the national average.

Howard R. Champion, M.D./Cont'd
William J. Sacco, Ph.D.
Washington Hospital Center

The M statistic compares the severity mix of a particular patient population to the patient population on which the national outcome average was based. For these data, the M values must be greater than .87 for the Z statistic to be meaningful. If the M factor is not greater than .87, one should reserve judgement about the Z values.

Each institution received a series of 2-dimensional graphs, as shown in Examples 1 - 4. The values for the Trauma Score (TS) and the Injury Severity Score (ISS) are plotted on the graph, as shown in Examples 3 and 4. Survivors are represented by a "L"; "D" represents deaths; "B" means both survivors and deaths at that location. Multiple survivors or deaths occurring at one TS-ISS location are designated by a number above the letter. For example, the three characters below indicate 36 patients survived at a particular TS-ISS coordinate "3"

6
L

The diagonal lines crossing the graph, called the PS 50 lines, represent the national norms for the 50% chance of survival for two age groups. Patients whose TS-ISS values fall below the line have at least a 50% chance of survival and would be expected to live based on the severity assessment by the Trauma Score and Injury Severity Score. Those who fall above the line have less than a 50% chance of survival and would be expected to die.

Age had a substantial effect on outcome in this data set. Consequently, two PS 50 lines were determined for both penetrating and blunt patients: a line for patients between the ages of 15 and 54 and a line for patients 55 and over (Examples 1 and 2). The top line is for the younger group.

Results showed that the Z values for the participating hospitals ranged from +3.17 to -4.17. Almost all the institution had an M value above .85.

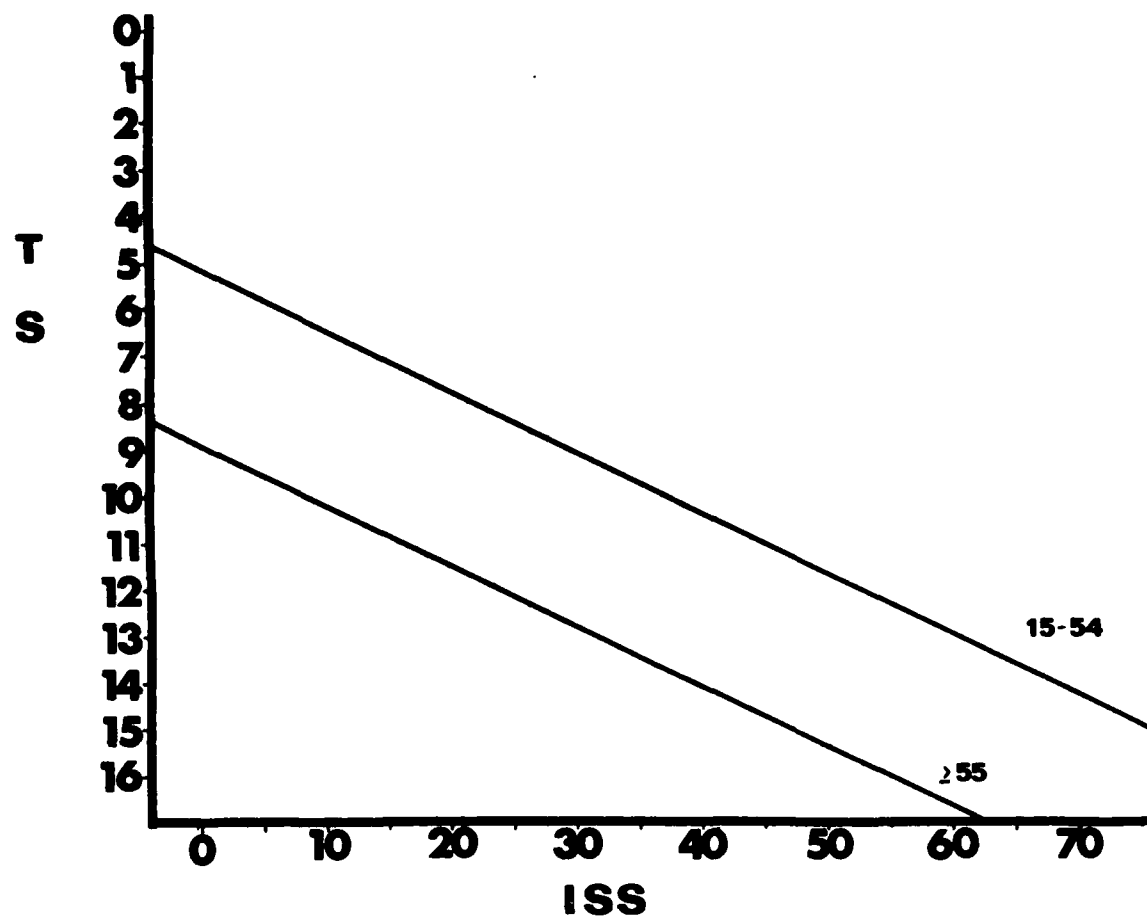


FIGURE 1: PS 50 Lines for Blunt Injured Patients

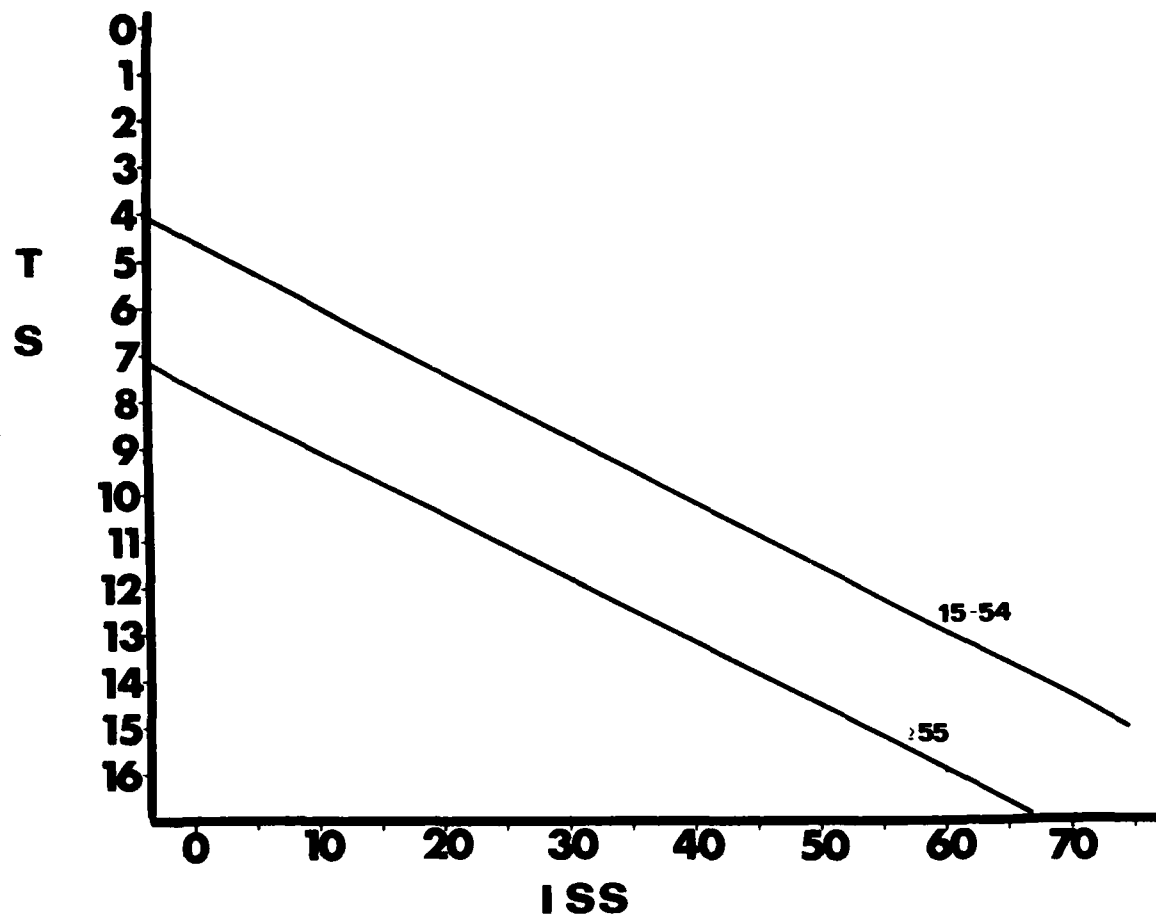


FIGURE 2: PS 50 Lines for Penetrating Injured Patients

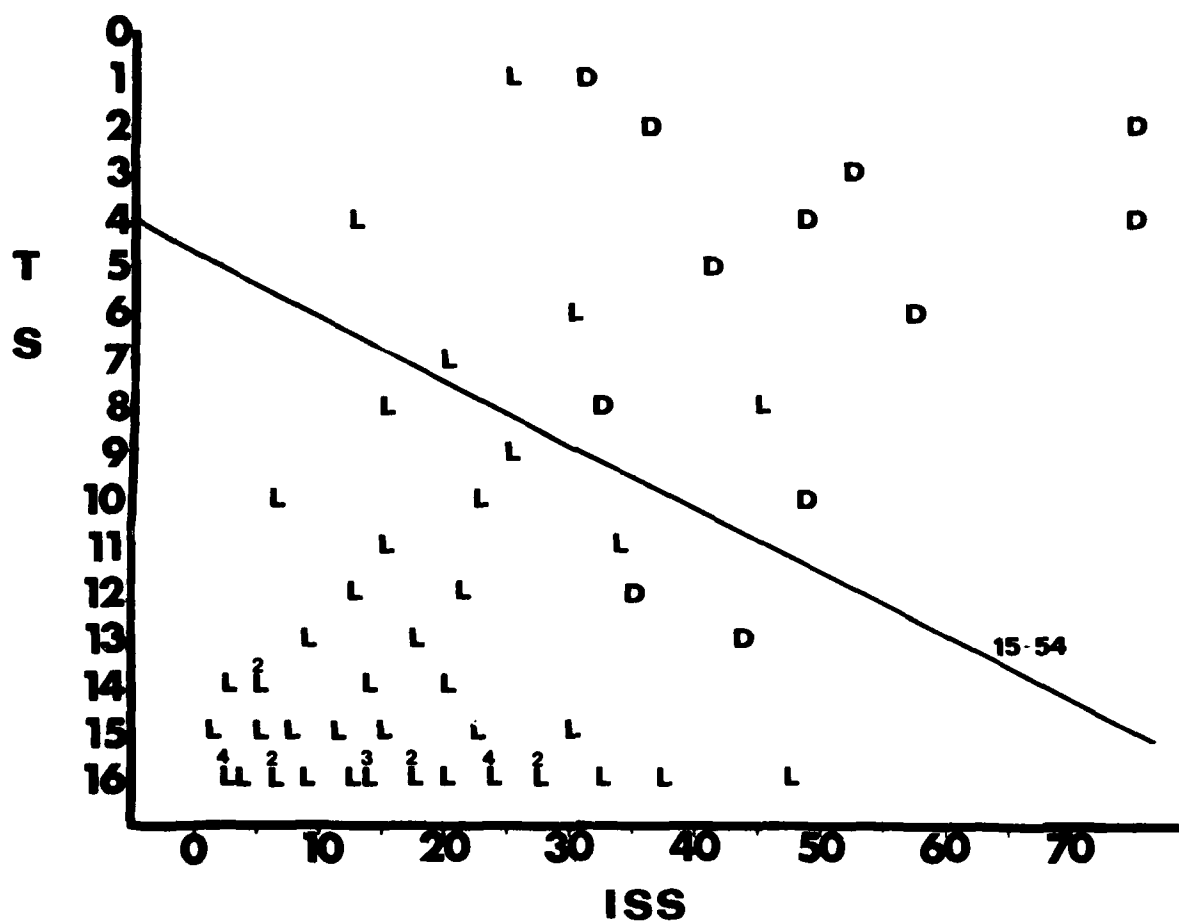


FIGURE 3: Example of Penetrating Data Ages 15-54

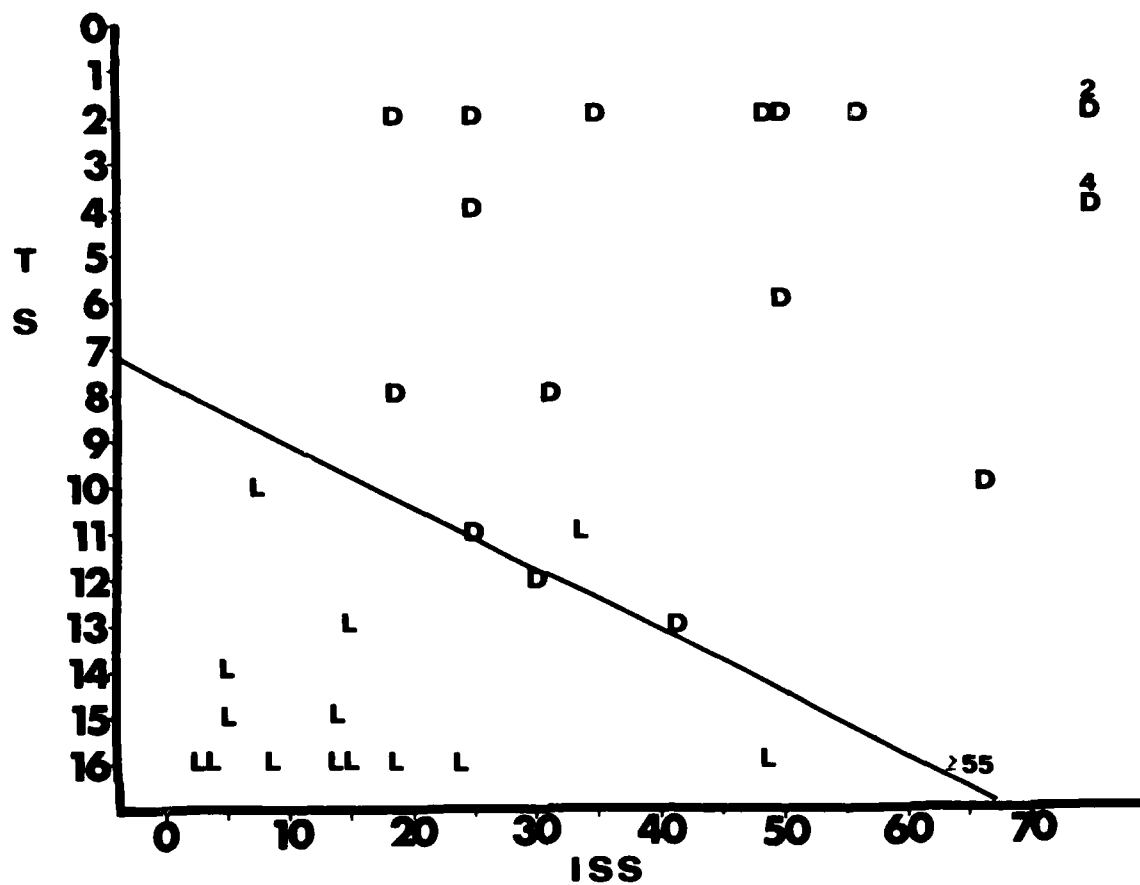


FIGURE 4: Example of Penetrating Data ≥ 55

Pre-Hospital Trauma Triage

Glen Kane, M.D.
Los Angeles, CA

Triage is defined as the field selection of injured patients to be taken to trauma centers. The importance of pre-hospital triage is emphasized when one considers what happens when triage is not done well. There are two types of errors. The first error is to fail to send to trauma centers those patients who ought to go there and occurs when triage techniques are low in sensitivity. The second type of error is sending to the trauma center many patients who need not go there which occurs when triage techniques have low positive accuracy rates.

This study aimed at developing and evaluating a valid and practical pre-hospital trauma triage instrument. The study, conducted in Los Angeles County, was completed in five phases: (1) the selection of a gold standard--that is, a criterion for identifying those patients who should have gone to a trauma center; (2) consideration of a wide range of variables measured by paramedics that would select in the field those patients whom the gold standard would ultimately say should have gone to a trauma center; (3) testing the pre-hospital variables to see which ones were the best predictors; (4) the construction of the actual triage instrument; and (5) assessment of the validity of the instrument.

The problem of trauma triage is to identify a certain category of patients on the basis of an early quick assessment by the paramedics in the field. The definition of that category of patient, the major trauma patient, is the gold standard. Because of the political and clinical controversies over trauma centers, the researchers created three gold standards so that the data could be run three different ways, allowing the reader to choose the gold standard he felt most appropriate and to accept the implications of that choice. The standards were as follows:

Gold Standard 1: Any patient who has an ISS greater than or equal to 25 or has major surgery or dies within two hours of hospital admission;

Gold Standard 2: Any patient who has an ISS greater than or equal to 15 or who has major surgery or dies within six hours of hospital admission;

Gold Standard 3: Any patient with ISS greater than or equal to 15 or who has major surgery within six hours of hospital admission or dies at any time or who has a diagnosis on a predetermined list of therapeutically complex lesions. The list of complex lesions was determined by a panel of three surgeons from USC Medical Center representing neurosurgery, orthopedics, and general surgery.

The candidate pre-hospital variables were then chosen. Many pre-hospital variables currently in use were considered: physiological, anatomical, mechanism of injury type variables. These candidate pre-hospital variables were tested by an empirical study conducted in LA county, a region currently without a trauma system. The area involved included a population of 650,000 in an area served by four local fire departments. The study lasted 5 months. Every patient seen by a paramedic of one of the four fire departments was enrolled in the study if he had an injury and was transported to the hospital. Data were collected at two points in the patient's course: while the patient was still in the field, radio contact was made with the base hospital by paramedics. At the base hospital radio, a medical intensive care nurse recorded enough data to rate every patient according to each of the candidate pre-hospital variables. Then, after the patient's death or discharge, the hospital chart was reviewed and sufficient data was pooled to categorize each patient according to each of the 3 gold standards as requiring trauma center care or not.

The two data sets were merged and the data analyzed to evaluate how well each of the candidate pre-hospital variables, alone and in combination, predicted whether a patient required trauma center care according to each of the 3 gold standards. Three statistical techniques were used: a bi-variate analysis, plotting a matrix (gold standard status vs. the status of each patient with regard to each of the pre-hospital variables); a step-wise logistic regression (a multi-variate technique which brings into the model as many variables as are necessary to achieve statistically significant prediction of the final result); and a strategy of using step-wise logistic regression, called hierarchical modeling, aimed at simulating the branching logic inherent in the clinical process.

The triage instrument was then constructed and the test of practicality applied. The validity of the instrument was assessed and compared with the validity of other triage tools. Validation was performed on the design set. Sensitivity and rate of positive accuracy were determined to be the most important validators.

Preliminary results showed that of the 937 cases in the study (5% mortality rate) only 548 had complete data sets: the variables most often missing were capillary refill, respiratory rate, respiratory effort, and blood pressure. The choice of a gold standard determined different patients being triaged to the trauma centers.

One instrument was constructed that was intended to triage patients for Gold Standard 1; its variables included two physiological measurements: a simplification of the Glasgow Coma Scale and the elements of the Trauma Score; three measures of abdominal injuries; one measure of thoracic injuries and two measures relevant to motor vehicular injuries. (Checklist A)

A multivariate analysis was then performed which excluded the four variables that were most often missing. This yielded 856 patients. Additional variables were then made part of the scale: gunshot wounds to the chest was added, as well as penetrating cranial and neck wounds, flail chest, and a fall from greater than 15 feet (Checklist A1). The physiological measurements remained the same.

Checklist A, based on 548 cases, had a sensitivity of 91% and the positive accuracy rate was 15%. Checklist A1 based on 856 cases, maintained the sensitivity rating and had only a trivial loss in positive accuracy, and a gain in face validity. Using the sample of 548 cases, several indices were subjected to validation: the Glasgow Coma Scale, the CRAMS scale, the Trauma Score and Checklist A. The results showed that triage measurements based on physiological factors alone were inferior to those that added mechanism of injury and anatomical factors.

A Description of Military Triage

Barry Wolcott, M.D.

An understanding of a military triage situation as it currently exists is necessary before one can consider how to use triage indices in that environment.

A basic description of a "Corps" is set out below: A corps is the next step up from a division and the next thing down from an army. It has somewhere between 100,000 and 300,000 people in it, depending on the type and number of divisions in it.

A corps having 3 divisions will contain between 45,000 to 55,000 fighting men and another 55,000 to 100,000 persons supporting them. In that system, there would be approximately 1,800 EMTs and paramedics (not counting those staffing free-standing clinics and mobile vans); 100 battalion aid stations (mobile critical care vans), which also act as a visiting nurse station to approximately 500 men; twelve mobile emergency trauma rooms, which also function as mobile minor treatment facilities or free-standing emergency clinics; three sixty-bed MASH hospitals; three 200 bed combat support hospitals; six four-hundred bed evacuation hospitals; approximately 70 Huey helicopter-ambulances, and approximately 400 ground ambulances. Approximately 10% of the force are medical personnel. On a busy combat day, the system would generate about 4,000 trauma victims, plus about 150 medical patients; approximately 1% of the patients will be sick enough to need to be seen by a physician in a medical care facility.

The locale of the fighting would probably be in another country, where English would not be the spoken language in the fighting environment. Also, the allies with whom we would be working most likely would not speak English, and almost uniformly, we would not be able to speak their language. We would, therefore, have to rely on interpreters.

The military triage system as it currently exists was designed to sort disasters on the scale of nuclear war. It was not designed for day-to-day operational business in the setting just presented. The four triage categories are "expected", "immediate", "delayed", and "minimal". These categories are agreed upon by all NATO allies, but designed for nuclear war. Because that is all that is available, however, this system is used in the day-to-day combat environment. There are three other terms, "priority", "urgent", and "routine", that are used for air evacuation. There will be varying interpretations of these terms among the different services. This will result in major differences in the criteria taught for the purpose of sorting mass casualty patients.

Barry Wolcott, M.D./Cont'd

There are a number of problems of resulting from this. The first involves clinical judgement required to make triage decisions, i.e., how quickly does the victim need medical care. Just as there is DRG creep, there is classification creep: if a helicopter is called on an "lesser" basis, the patient will not be picked up for 12 hours. Consequently, everything tends to become a priority.

The second problem is that the judgements are made locally, independently of what's going on in the big picture. A physician and a PA run battalion aid station that is one of 100. Yet, they compete for ambulance resources with the other 99. If they have a patient who they want to transport out, they may call it a "priority" in order to get the patient out, and in doing so take the resource away from a sicker patient. This encourages lengthy radio discussions to improve the resolution of the terms--extremely difficult in combat situations. It is difficult for a similar reason to characterize the patient for our Allies: determining what is a "priority" has different meanings. The third problem is that it is extremely difficult to audit the pre-hospital care system. In a system with 4,000 casualties a day, it would be useful to find out who is doing a good job, as opposed to who has a certain number of priority patients, etc.

It is evident that the triage system used is not very useful and needs improvement. There are several questions that I would like to see addressed at this meeting:

1. Do the various scoring systems reflect mortality independently of the sophistication of the medical care system that finally produces the final care, and independent of the delay to definitive care? In other words, is a patient who is a "12" always sicker than a patient who is an "8", but the mortality may vary according to what kind of facility takes care of the patient?

2. Can the military expect operationally significant improvement in the powers of these scoring systems in the next two to five years? Or has the maximum been reached in improving the usefulness of these scores?

Comments on Triage in Orange County, CA

John West, M.D.
Orange County California

There is much dissatisfaction with the triage criteria previously devised. There are many political, clinical, medico-legal, economic and legal problems associated with triage. This discussion will provide a brief overview of triage development in Orange County.

When the trauma system was first implemented in Orange County, simple triage criteria were devised: BP less than 90; cardiac arrest in the field; severe cardio-pulmonary distress. The BP identified critically ill patients that needed to go to a trauma center; about 60% went to the OR within the first two hours of arrival, many of the others died in the ER or had emergency thoracotomies. During the first year, we saw about half as many critical trauma patients were seen as anticipated.

Many of the patients with non-CNS injuries who looked deceptively stable in the field were transported to non-trauma centers. Orange county is an urban system; our response time is excellent--vital signs are normally taken within 4-6 minutes of the injury. Retrospective examination showed that these vital signs were deceptively stable in the field and no mis-triage had occurred.

After about two years, it was apparent that severely injured patients were going to the non-trauma centers. The base station physician and ICU nurse began to use their judgement and interpret the vital signs. Over the next year, we tended to look for early signs of shock and accept some degree of vaso-constriction, slow capillary refill, to be more liberal on respiratory problems and to shift to sending more patients to the trauma centers. We thus saw a gradual increase in admission to trauma centers. The numbers of patients seen in the ER who went on to surgery was reduced.

We went to a scale with physiological parameters, based on committee input. The parameters were interpreted very liberally: the earliest signs of shock, penetrating injuries, multi-system CNS injuries, 15 minutes of unconsciousness, lateralizing vital signs, open head injuries, etc. Since June, Trauma Scores have been completed on all these patients.

The trauma centers are now seeing large numbers of patients; the numbers of patients going to surgery within the first two hours has dropped to about ten percent, however. There are problems also: our university trauma center is running at maximum capacity and is having a bed problem; hospitals that do not have in-house trauma teams are being called out frequently for patients who are actually non-major trauma. A major problem is in the interpretation of mechanism of injury; there is not good enough data for paramedics or MICU nurses to use the mechanism of injury information to make a good triage decision. It is important to take this data, re-adjust, and fine-tune the system. The medico-legal decision of triage is becoming increasingly important. If a patient is triaged to a non-trauma center and does poorly, there is major legal exposure. This may tend to encourage over-triage.

Triage in Orange County, Cont'd

Rick Cales, M.D.

(Former Medical Director, Orange County, CA)

There may be too much emphasis placed on the concept of involving the physician with the triage of the patient. In Orange County, the base station physician, the highest authority available, was involved with the triage of the patient, since triage was a very political issue. Triage of multiple patients at the scene is handled better if there is on-line medical control: no center is over-burdened.

As an addition to Dr. West's remarks, I will briefly discuss data collection that has directly to do with triage. Potential salvageability dropped from 34% in the first study before trauma centers down to about half of that in the second study. To determine why there was such a large number of potentially salvageable patients, the data was divided between the trauma and non-trauma centers. Of sixty deaths, 13 were treated outside the system in non-trauma centers, and 7 of those were potentially salvageable. Forty-seven patients were treated in trauma centers of whom two were potentially salvageable. Twenty-two percent of the deaths in the system occurred outside the trauma centers. This did not take into account any morbidity.

Eventually additional criteria were added for triage: CNS--as evidenced by decrease in consciousness, comatose, or some kind of localizing sign or spinal cord injury; penetrating injuries are limited to the head, neck, and torso; mechanism of injury is now included, although interpretations vary as to what this is. Additionally, the Trauma Score was added, although the majority of the patients are triaged by the other criteria. What is used, therefore, is a combination of three factors comprising a triage rule: anatomic, physiologic, and a severity scale.

Testing of the Navy Corpsmen
Howard R. Champion, M.D.
William J. Sacco, M.D.
Washington Hospital Center

While the Trauma Score has been used successfully in civilian settings, its value in a military environment, e.g., for triage of mass casualties in combat, is undetermined. Triage is the cornerstone for handling mass military casualties and is used to generate the most efficient use of limited resources. The feasibility of using the Trauma Score in the early triage of casualties, however, would be dependent upon the ability of Hospital Corpsmen to accurately and quickly determine the Trauma Score assessments in the difficult conditions of combat. This study was directed toward determining the accuracy with which Navy Hospital Corpsmen performed the Trauma Score on trauma patients in surgical intensive care units and trauma "step-down" units.

The participating corpsmen were briefed at the base by the principle investigator on the scientific basis and application of the Trauma Score for triage and evaluation of care. The corpsmen were then trained for two hours on the technique of performing the Trauma Score. The training was conducted via videotape by physician demonstration on a simulated casualty. The corpsmen were tested using a set of ten written Trauma Score assessment exercises.

Patient testing took place at two of the Washington Hospital Center's Surgical Intensive Care Units and two of the trauma step-down units. A one-hour Trauma Score assessment review and question and answer session was conducted prior to the testing. Patients were selected prior to the testing by Nurse Research Assistants. The selection was based on the need to provide a mix of patients for testing with normal and abnormal variables.

The testing occurred on two surgical intensive care units and two step-down units. For most of the corpsmen, this was their first experience with critically ill patients. Each corpsman was required to complete Trauma Score assessments on five surgical ICU patients. A Nurse Research Assistant, experienced in Trauma Score assessments, acted as an Independent Observer (NRA-IO). The NRA-IO evaluated the corpsmen for compliance with the operational definitions and appropriateness of technique used to measure each variable of the Trauma Score.

After each corpsman completed and recorded his TS assessments for each patient, the NRA-Independent Observer immediately completed and recorded a Trauma Score assessment on the same patient. The Trauma Scores completed for each patient by the corpsmen and the NRA-Independent Observer became one data pair, along with any additional observations made by the NRA. Each data pair was reviewed and analyzed to determine if the corpsmen's scores matched the NRA-IO's scores.

Results showed that the Navy Corpsmen can complete the Trauma Score accurately and reliably. Their accuracy improves with practice on real and simulated casualties. A total of 94 Trauma Score assessments were completed on patients by the corpsmen and by the NRA-Independent Observers. For 61.7% of the observations, there was agreement in the Trauma Score assessment; in 29.8%, there was disagreement of only one point. Some of the bigger errors were due to the fact that the corpsmen forgot to assess the systolic blood pressure on the SICUs.

The corpsmen were later field-tested with physiologically moulaged patients at a battalion aid station and at a holding station. An observer was assigned to every simulated casualty. In the field, no systolic

blood pressure was taken and was, therefore, not part of that test. During the field testing, conditions were poor due to rain and mud. The observer and the corpsmen Scores were compared. There were 26 assessments made in the controlled field environment, 23 with no disparity and 3 with a disparity of one point. At the battalion aid and holding stations, there were 12 agreements and 3 disagreements.

Overall results showed that the corpsmen were capable of performing the clinical assessments required by the Trauma Score, with minimal training and virtually no experience on the part of the participating corpsmen.

There are modifications that are probably required for the Trauma Score to be used by the military in combat situations. Systolic blood pressure is rarely taken in the field, simplified versions of the Trauma Score are under consideration. One version of the TS does not have a systolic blood pressure in it, leaving respiratory rate, respiratory effort, capillary refill, Glasgow Coma Scale. Another version, even simpler, "RPM" (respiratory rate, pulse rate, and motor response only) is being examined to see how much power is lost with the a simpler version. Both versions are good predictors, about 90-93% as powerful as the Trauma Score, easy to memorize, require less time to do, and can be used at all echelons, including at the scene of wounding.

Even though these versions reduce the power of the Trauma Score to 90-93%, equivalent power can be regained by two simple refinements: (1) by decomposing any one of these response scores into two parts, the circulatory/respiratory part and the neurological part, yielding a two-dimensional chart in which both axes physiological axes; and (2) by partitioning the data into (a) patients with serious head injuries; or (b) patients who do not have serious head injuries. The information gain is then raised to the equivalent power of the original Trauma Score.

Inter-hospital Triage

Howard R. Champion, M.D.

The following are criteria that we use for inter-hospital transfer. Approximately 80 - 85% of the patients referred to us have an Injury Severity Score of 20 or greater. We compile information on the transferred patients and send it back to the transferring hospital as feedback on their triage decisions, which are made by physicians.

1. Burns. Greater than 20% total body surface, respiratory involvement, face, head, feet hands and perineum.

2. Trauma.

i) Central Nervous System--

- a. Head injured--when C/T scan would constitute optimum care, e.g.
Severely obtunded--Glasgow Coma Scale less than 10.
Lateralizing signs.
Deterioration level of consciousness.
Penetrating injury or depressed skull fracture.

b. Spinal Cord Injury

ii) Chest--wide superior mediastinum on upright chest X-ray.

iii) Abdomen/Pelvic--disruption of pelvic ring in two or more places.

iv) Combination injuries--particularly:

- Severe face injury and head injury (Mortality 34.4%)
- Chest and head injury (Mortality 50.9%)
- Abdominal or Pelvic and head injury (Mortality 55.4%)
- Thoracic and abdominal injury (Mortality 36%)

v) Secondary Deterioration--respiratory failure or sepsis in combination with late onset (24 hours +) deterioration of cardiac, hepatic, renal or central nervous system function)

vi) Limb reimplantation candidates.

Use of Helicopters in Transporting the Trauma Victim

Bill Baxt, M.D.

We used the Trauma Score/Injury Severity Score/and age methodology to compare the mortality of two groups of 150 consecutive blunt trauma patients. One group was transported by a helicopter system staffed by a physician and a nurse, and the other was transported by land either by ambulances staffed by two EMTs or by mobile intensive care units staffed by two paramedics. The helicopter system used a team of one acute-care physician and one nurse trained to perform oral or nasotracheal intubation and to administer a broad spectrum of medication.

Both groups of patients had sustained blunt trauma, were treated at the scene of injury, and transported to the same trauma unit. No patients had CPR performed on them in the pre-hospital phase; patients who had no spontaneous respiration or pulse at the scene and received no resuscitation were excluded.

Trauma Scores were determined for the land patients by a physician at arrival at the trauma unit and for the helicopter patients at initial contact by the helicopter physician. Injury Severity Scores were obtained from patient charts and autopsy records.

Results showed that regarding the time factor, use of the helicopter occurred most frequently in rural areas with low population. The first responders in those areas were the EMTs with advanced first aid. The land patients were cared for first by paramedics. The paramedics cannot intubate, but rather use the EOA. Also the paramedics cannot use mannitol. The time to initial patient contact was almost the same in the two groups. Consequently, the helicopter is not providing a significant advantage over the land transported patients in that respect. When the time from injury to arrival at the trauma center was examined, the land group had a 35 minutes average time and the helicopter group had a 58 minutes average time. So the use of the helicopter and the medical team was actually delaying treatment to definitive care by 23 minutes.

In the aeromedical group, 20.62 patients were expected to die, but only 10 actually died; in the land group 14.79 patients were predicted to die and 19 actually died. Data showed that the patients who died in the aeromedical group died of much more severe injuries; the average probability of survival of the nonsurvivors in the land group was .508; the average probability of survival of the nonsurvivors in the aeromedical group was .360.

The researchers are currently collecting data from other helicopter programs. Results from this effort are in the preliminary stage.

The complete report on this study is available in JAMA, June 10, 1983. Vol 294, No 22, Page 3047.

Group Reports

Methods - Questions

- Discussstion with Whole Group
- Final Half Day Spent Forum Taking Recommendations

QUESTIONS TO BE ADDRESSED RELATING TO TRIAGE AND INJURY SEVERITY

1. What information can be acquired at the trauma scene that should be integrated into the triage decision?
 - a) Patient status
 - Physiologic data - Should the Trauma Score be changed?
 - Anatomic data
 - b) Mechanism of injury
 - c) Prior disease
 - d) What other elements should be considered?
 - Time
 - Distance
 - Resources
2. Should a physiologic severity score correlate with outcome and at what point following injury is it most valid?
3. What factors need to be considered in secondary (interhospital) triage?
4. How do you exclude patients who don't need the system?
 - Low severity
 - High severity
 - Resource constraints
5. What are the decision rules for priority triage?
 - Military
 - Civilian
 - Special situations
6. What level of training is needed for triage and who should make triage decisions? What is the role of communications/medical control?
7. What is the accuracy of physician extender in obtaining information for the purpose of triage?
8. What is the role of an anatomical severity index in the field, the emergency department, and the in-hospital setting?

Q U E S T I O N S

1. Define a TRIAGE Rule with the following components.
 - a. Physiologic score CNS + Cardiorespiratory variables
 - b. Anatomic variables, e.g. penetration torso
chin to knees
 - c. Co-morbid factors, e.g. age, renal, hepatic failure
 - d. Mechanism of injury for field triage
2. What are the resuscitation skills needed, prior to definitive care? e.g. IV intubation, extrication. Consider primarily field treatment, but also BAS or rural E.D.
3. Can the index in (1) be used to:
 - 1) Interhospital Triage
 - 2) Priority Triage.

Definitive Care may be
delayed 12 hours.
4. What is the role of anatomic indices (ISS)

Group I
Don Detmer, M.D.
Group Leader

The group discussed four major aspects of trauma triage (a) Criteria for triage to trauma centers; (b) criteria for triage in a mass casualty situation; (c) resuscitation skills needed prior to definitive care; and (d) education and research needs.

Regarding criteria for triage to trauma centers, the group recommended that an assessment of poor perfusion status was needed. The group felt that several measures could be used for this assessment, including capillary refill blood pressure, pulse rate and color. Secondly, the group determined that the criteria should include an assessment for evidence of central nervous system injury, whether it be the Glasgow Coma Scale, inability to open eyes on demand, or a mix of variables. Thirdly, the group recommended that an assessment of respiratory distress be included in criteria for trauma center triage. Finally, the criteria should contain a set of mechanism of injury rules; five potential parameters were considered: (1) whether extrication was needed; (2) whether the patient space was isolated; (3) presence of major burns, a patient who had burns with trauma would go to a trauma center; (4) evidence of a fall of greater than 15 feet; and (5) presence of a penetrating gunshot wound.

Regarding co-morbid factors to be made part of a triage rule, the group recommended that age be factored into a triage decision. For example, there would be a different threshold at which to triage or transfer a patient to a trauma center if the patient were under 14 or over 70.

The group turned its attention to triage in a mass casualty situation. The group recommended that the basic principle of triage under these circumstances should be to do the greatest good for the greatest number. The group recommended a two-tiered triage scheme, the first triage for resuscitation and the second triage for definitive care. Thirdly, the group discussed the structure and process variables that needed clarification, including (1) patient mix; (2) environmental factors (such as urban, rural and suburban; geographic conditions; weather) and (3) resource capabilities, including the quality of the field and hospital personnel and the trauma system capabilities. The group felt that these things might structure and influence that approach to triage.

Skills were divided into two groups: (1) skills needed in the field; and (2) skills needed when you could not move patients for 12 or 24 hours, as in a military situation. For evaluation of patients in the field, training at the EMT I level was needed. For evaluation and treatment, training at the paramedic level was needed. Specific skills needed in the field were (1) extrication; (2) airway management, which should be taught more aggressively in terms of intubation; (3) bleeding of control; (4) immobilization; and (5) splinting. In terms of management, a priority in proper volume management, with the emphasis on treating the volume situation in terms of keeping the patient alive.

Finally, regarding research, a paramount concern was what types of injuries should be treated at the scene and what should not be treated at the scene. Research should be conducted into the usefulness of IV's and fluids in the field as well as time spent in treatment at the scene vs hospital trade offs. MAST was also listed as a research priority. The group conceded that while use of MAST raised blood pressure, there was no indication that survival was improved. The group recommended that research should be conducted to answer the question of when the system should be stopped, especially for a patient with the "Humpty Dumpty Syndrome". Other areas needing research were tension pneumothoraces, cricothyroidotomy, the air lifting of injured soldiers who have had a laparotomy, thoracotomy, or air in the head.

Group II
John Sacra, M.D.
Group Leader

The group felt that there was a need for a hierarchy approach to triage and that an anatomic entity or mechanism of injury might be present that would automatically necessitate triage to a trauma center. The group felt, however, that there was a need for an objective, reproducible, and statistically significant system based upon a scoring system that would provide a common language; that paramedics could speak to a trauma center; or outlying hospitals could speak to trauma centers; and that battalion aid stations could speak to the people at the MASH or Evac hospitals.

The group since it had been extensively studied, had been shown to be a useful tool, and was statistically sensitive. The group felt strongly about the validity and the strength of the Trauma Score and its ability to communicate for both civilian and military populations. The group suggested that a Trauma Score equal or less than 12 or a Glasgow Coma Scale equal or less than 10 would necessitate triage to a definitive care facility. Additional factors, such as anatomical or mechanism of injury factors would be facilitators that would work around the basic Trauma Score in conjunction with the Glasgow Comas Score. These factors would be used on the scene of a very bad wreck with a bad injury. In those circumstances, the emphasis would be on detecting a bad physiological development that has not yet be manifested, consequently a total evaluation of the situation would be warranted. In that situation, a Trauma Score can be calculated enroute to the hospital.

These special situations were defined as such, If certain mechanisms of injury conditions or anatomical conditions were present at any point, the patient would automatically be transferred to a trauma center. These conditions were:

- o penetrating wounds of the head, neck, and torso
- o major burns, the definition of which would depend on whether the patient was being referred to a major burn center or not
- o spinal cord injuries with paralysis or motor loss
- o flail chest

The mechanism of injury categories were:

- o extrication taking longer than 20 minutes
- o falls greater than 15 feet
- o evidence of rapid acceleration/deceleration in a motor vehicle accident which included entrance of the offending object into the passenger compartment.
- o ejection from the car

Regarding the military, currently the military uses four levels of triage:

1. expectant - expected to die
2. immediate - requiring immediate care
3. delayed - those with less severe injuries
4. minimal - expected to return to duty

The group saw no need for abandonment of the system but suggested a further breakdown of those groups in more specific manner using mechanism of injury, Trauma Score and Glasgow Coma Scale. This would allow the military to subgroup their cases and more easily determine who received care on priority for transport system. The resulting system would be similar to civilian disaster staging.

The group felt that use of the Trauma Score as such would remove the need for clinical judgements made locally without the benefit of knowledge of the entire battle scene. If the Trauma Score was communicated back to the back lines, then the decisions would be made there as to how many and what numbers to transport at any particular time. Also the concern of lengthy radio conversations to resolve issues would be eliminated because the triage system would be distilled into communication of numbers. An additional concern raised by the military was the difficulty in communicating with Allies, because of the difference in terminology. Use of the Trauma Score would give a common language in which to communicate. The last concern of the military was difficulty of auditing since patient mix couldn't be determined. The severity indices to control for patient mix would be built in to this system. Thus, the triage system would be suitable for both civilian and military triage needs.

Regarding the co-morbid factors, in general, other than age, the group felt that co-morbid factors should be a secondary feature of inter-hospital transfer, rather than of field-to-hospital transfer. Otherwise, the group felt that paramedics in the field would be doing exhaustive histories.

Regarding resuscitation skills needed in the field, the group encouraged the use of the "A, B, C's". Treatment of circulation should be through whatever means are necessary, including IV treatment. Expeditious and rapid transport and with no delays at the scene was emphasized. The amount of time allowable for doing different procedures at the scene should be decided at the local level by local medical control.

Regarding resuscitation at the battalion aid station or rural hospital, the group felt that the ATLS course should be the yardstick for the knowledge needed here. Rapid and expeditious transport should be emphasized more than it has been in the past, with more attempts to train medics to start IVs in the back of the ambulance while enroute to the hospital.

Regarding research, the group felt that further research was needed into what would be acceptable mortality measures. These measures should take into account the differences in geographical areas, capabilities of hospitals, etc. The group discussed certain errors that occurred in the application of the Trauma Score: (1) where the Glasgow Coma Scale was out of proportion to the Cardio-respiratory scale; and (2) where the mechanism of injury is sufficient, but where physiologic deterioration has not occurred, but can be predicted as likely to occur. The group felt that further research into these areas would be useful. Also the group noted that no data is available to predict outcome over delayed periods -- e.g., what would happen to a Trauma Score of "12" delayed over an extended period of time. The group felt you could estimate and be accurate in your assessment if the following were done: (1) very carefully separated the CNS index from the cardio-respiratory index and (2) serial Trauma Scores would be helpful to continually update the dynamic process that was going on. Even with these limitations, the group felt that the Trauma Score would be helpful currently in disaster situations or in the military by allowing prioritization and optimal use of available resources.

Group III
Ken Mattox, M.D.
Group Leader

This group proposed a binary triage decision rule incorporating criteria for pre-hospital field triage in either military or civilian settings. The group felt that use of the decision rule would address the question of who should go to a resource facility, i.e., a trauma center in civilian system or a surgical hospital in military settings. The group proposed a 3-tiered approach to triage: a quick look, a secondary assessment, and a tertiary assessment.

o Quick Look - This assessment would be completed within a matter of seconds. Those who had the following conditions would automatically go to a resource center; (1) cardiac arrest, (2) uncontrolled respiratory distress (including flail chest, defined as a respiratory rate of greater than 15 or less than 5 within 30 seconds; (3) shock; (4) weak, thready, rapid pulse; (5) unconsciousness or motor loss; (6) penetration of the torso; (7) major burns, including blast and radiation; and (8) amputation.

o Secondary Assessment - This assessment would examine vital signs, blood pressure and Glasgow Coma Scale. The elements of the Trauma Score would be preserved for quality control, quality assurance and for staging purposes. Responsibility for determining triage for patients whose Trauma Scores fall between 12 and 14 would not fall to the EMT or paramedic.

o Tertiary Assessment - The group proposed an assessment called "Score Four" that took into account mechanism of injury age, co-existing disease, environmental conditions and multiple system injuries. Using this assessment, if a patient's condition achieved a score of four, the patient would be triaged to resource facility. The factors comprising the proposed system were:

- | | |
|---|---|
| I. High energy transfer (mechanism of injury) | |
| Severe high energy | 3 |
| Moderate | 2 |
| Minor | 1 |
| II. Age | |
| > 60 or < 12 | 2 |
| 12 - 60 | 1 |

III. Co-existing disease	
Severe	3
Moderate	2
Minor	1
IV. Environmental Conditions	
Severe	3
Moderate	2
Minor	1
V. Multiple System Injuries	
Severe	3
Moderate	2
Minor	1

Regarding the Trauma Score, the group felt that it was a useful tool. The group did feel, however, that there was an implied pressure to justify the continued use of the Score. The group stated that the objective of the conference was to get a triage mechanism that would get the patient to the right place. The group felt the Trauma Score was one of several tools that would do this.

With regard to anatomic variables, the group listed the following items as important to consider:

- o major amputation (anything above the ankle and wrist)
- o major burns (greater than 30%)
- o penetrating torso (neck to knees)
- o multi-system trauma
- o flail chest

The group agreed with the mechanism of injury factors suggested by other group reports, and further suggested that "hostile environment", e.g., hot desert, submersion in cold water) be added.

The co-morbid factors the group discussed age, but could not agree on how heavily it should be weighted. The group also believed that any acute illness that produced dehydration such as diarrhea, nausea, vomiting or chronic dehydration should be weighted higher than age, e.g., a soldier who does not drink water and is already 15-20% dehydrated when he is shot.

Regarding resuscitative skills that should be required, the group felt that whether one waited five minutes or 12 hours before the skills are needed, one still had to train for their use. The group listed everything that other reports had listed plus pleural decompression as a training mode with supported local rules applying for its use.

The group concluded by stating that it did not think an index could be used for both priority triage and interhospital transfer.

GROUP IV.
Barry Wolcott, M.D
Group Leader

Regarding criteria for triage to trauma centers, the group felt the Trauma Score and Glasgow Coma Scale were useful for measuring physiological factors. The group suggested that research be conducted that would aim at applying technology in the pre-hospital setting to see if improved physiological information could be achieved. The following were suggested: ear oximeters; digital osmography; the ISFET, an in-dwelling catheter that measures gases; toe temperature; in-dwelling electrolyte measurements. The group also felt there was a need for a pneumo-hemothorax detector, since this was one of the kinds of injuries that was missed. Further, some way of measuring the competency of the airway should be explored.

There was consensus in the group that the following variables be examined to see if additional power could be added to a triage rule incorporating them. These variables were:

- o maxillofacial
- o head/neck
- o trunk
- o extremity open
- o extremity closed.

In terms of mechanism of injury, the group suggested the following be examined:

- o blunt v. high velocity penetrating
- o blunt v. low velocity penetrating
- o Delta v. over T, in terms of the change of velocity over the bodies.

The group felt that a scoring system that was used in the pre-hospital phase could also be used at the receiving hospital to identify obvious pre-hospital triage errors. Once identified, patients could be re-routed to the appropriate hospital. The group also suggested that anatomic criteria could play an important role in inter-hospital triage.

The group also felt that index could be used in a disaster triage setting. In this setting, a category termed "expectant" could be created, the measuring of which could be varied with the magnitude of the disaster and the available resources.

In terms of other research needs, the group felt it was important to examine changes in mortality based on injury over time to determine the time penalty for delay in care, both in the pre-hospital and inter-hospital phase. The group suggested that another conference be held to examine data available through the academy of Health Sciences to further examine the use of Injury Severity Scoring Systems. The group also suggested examination of the Trauma Score data in terms of length of stay as another kind of audit criteria for hospital care.

The group also suggested that when performing quality of care audits, participating hospitals be allowed to throw out totally unavailable deaths (e.g., an addict that get hit by a car and dies of liver failure), so that hospitals would be less reluctant to allow comparisons of their survival statistics.

Finally, the group stated that the Injury Severity Score was not useful for triage, but rather that its usefulness was for in-patient audit, in patient research and especially when it was combined with the Trauma Score.

Those attending the conference were interested in the effect of separating the Trauma Score into its two components; the respiratory-circulatory component and the neurological component. The following study was completed the conference expressly for this report.

The De-Coupled Trauma Score Applied to the ACSCOT Data

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The Trauma Score is a simple physiological measure of injury severity based on seven circulatory, respiratory and neurological assessments: respiratory rate, respiratory expansion, capillary refill, systolic blood pressure, eye opening, best verbal response and best motor response. The scoring system for these assessments is shown in Table 1. The Trauma Score is used for prediction of patient outcome, triage and monitoring, and evaluation of care (1 - 4).

Previous reports by the authors (5,6) have dealt with the Trauma Score and its application to field triage and combat casualty management of penetrating injuries. In one of the reports, it was shown that the predictive value of the Trauma Score was enhanced by two refinements; the de-coupling of the Trauma Score into two components, a respiratory-circulatory component, and a neurological component; and separate analyses of patients with and without serious head wounds. All of the data used in the referenced reports were from patients with penetrating injuries seen at Washington Hospital Center, Washington, D.C. over a 6 year period.

Washington Hospital Center has recently become the data collection site for a multi-hospital trauma study called the Major Trauma Outcome Study. This paper reports the predictive value of the de-coupled Trauma Score for patients in the study with penetrating injuries and aged 15 to 54. For the analyses, the patients were separated into two sets A and B. To qualify for Set A, a patient had to have at least one head injury with an Abbreviated Injury Scale (AIS) of 4 to 6. A patient with either no head injury or head injuries with AIS values of 1 to 3 was assigned to Set B.

The total number of penetrating injury patients aged 15 to 54 was 1460, 1346 (92.2%) survivors and 114 deaths. Set A had 107 patients including 52 survivors (48.6%). Set B had 1353 patients including 1294 survivors (95.6%).

The de-coupling of the Trauma Score was accomplished by separating the Trauma Score into a respiratory-circulatory component, C₁, and a neurological component, C₂. Referring to Table 1, the two components designated C₁ and C₂ are:

C₁: respiratory-circulatory component = A+B+C+D
 C₂: neurological component = E

Survival probability estimates were obtained for the de-coupled Trauma Score for Set A and Set B using logistic models of the form:

$$P_S = 1/(1 + e^{-b}),$$

where:

P_S = probability of survival

$$b = b_0 + b_1.(C_1) + b_2.(C_2)$$

and

b_0, b_1, b_2 are regression coefficients obtained from a regression algorithm.

The predictive values of the de-coupled Trauma Score were measured for each set A and B by relative information gain (R), average probability of survival for survivors, $\overline{P}_S(\text{survivors})$, and for deaths, $\overline{P}_S(\text{deaths})$, false positive rate (FP), false negative rate (FN) and misclassification rate (MR).

Results

The regression coefficients for the two data sets were:

De-coupled Trauma Score	b_0	b_1	b_2
Set A	-3.924	0.05251	1.340
Set B	-3.594	0.4225	0.8240

For each injury set, the logistic model was used to estimate a survival probability for each C₁, C₂ pair (Tables 2 and 3). For example, from Table 2, a patient with a C₁ value of 6 and a C₂ value of 3 (row 6, column 3) has a corresponding probability of survival of 0.60.

The predictive measures for each model were:

De-coupled Trauma Score	R	$\overline{P}_S(S)$	$\overline{P}_S(D)$	FP	FN	MR
Set A	0.79	0.83	0.16	0.14	0.055	0.093
Set B	0.76	0.98	0.42	0.005	0.41	0.022

Table 2 shows the decoupling effect of the Trauma Score on probability of survival estimates for patients with survivors head injuries. For example, decoupling of a Trauma Score of 10 leads to a range of survival probability estimates from P_S of 0.11 (for C₁ = 9, C₂ = 1) to a P_S of 0.95 (for C₁ = 5, C₂ = 5).

TRAUMA SCORE
CATEGORY DEFINITIONS, METHODS OF ASSESSMENT, AND CODES

		<u>RATE</u>	<u>CODES</u>	<u>SCORE</u>
A.	<u>Respiratory Rate</u>	10-14	4	
	Number of respirations in 15 seconds;	25-35	3	
	multiply by four	36 or greater	2	
		1-9	1	
		0	0	A. _____
B.	<u>Respiratory Expansion</u>			
	<u>Normal</u>	Normal	1	
	<u>Retractive</u> - Use of accessory muscles	Retractive	0	B. _____
C.	<u>Systolic Blood Pressure</u>	90 or greater	4	
	<u>Systolic cuff pressure</u> - either arm,	70-89	3	
	by auscultation or palpation	50-69	2	
		1-49	1	
	<u>No Pulse</u>	0	0	C. _____
D.	<u>Capillary Refill</u>			
	<u>Normal</u> -Nail bed color refill in			
	2 seconds	Normal	2	
	<u>Delayed</u> -more than 2 seconds capillary			
	refill	Delayed	1	
	<u>None</u> -No capillary refill	None	0	D. _____
E.	<u>Glasgow Coma Scale</u>			
	1. <u>Eye Opening</u>			
	Spontaneous	4	14-15	5
	To Voice	3	11-13	4
	To Pain	2	8-10	3
	None	1	5- 7	2
			3- 4	1
				E. _____
	2. <u>Best Verbal Response</u>			
	Oriented	5		
	Confused	4		
	Inappropriate Words	3		
	Incomprehensible	2		
	Sounds			
	None	1		
	3. <u>Best Motor Response</u>			
	Obeys Commands	6		
	Localizes Pain	5		
	Withdraw (pain)	4		
	Flexion (pain)	3		
	Extension(pain)	2		
	None	1		

Total GCS Point(1+2+3) _____

TRAUMA SCORE _____
(Total Points A+B+C+D+E)

TABLE 2

Survival Probability Estimates for Penetrating Trauma Patients of Ages
15 to 54 With One or More Severe Head Injuries (Set A)

C ₁ (Respiratory, Circulatory Component)	C ₂ (Neurological Component)				
	1	2	3	4	5
0	.070	.22	.52	.81	.94
1	.074	.23	.54	.82	.94
2	.077	.24	.55	.82	.95
3	.081	.25	.56	.83	.95
4	.085	.26	.58	.84	.95
5	.089	.27	.59	.85	.95
6	.094	.28	.60	.85	.96
7	.098	.29	.61	.86	.96
8	.10	.31	.63	.87	.96
9	.11	.32	.64	.87	.96
10	.11	.33	.65	.88	.96
11	.12	.34	.66	.88	.97

TABLE 3

Survival Probability Estimates for Penetrating Trauma Patients of Ages
15 to 54 With No Severe Head Injury (Set B)

		C ₂ (Neurological Component)				
C ₁ (Respiratory- Circulatory Component)		1	2	3	4	5
0		.59	.13	.25	.43	.63
1		.087	.18	.33	.53	.72
2		.13	.25	.43	.63	.80
3		.18	.34	.54	.73	.86
4		.25	.44	.64	.80	.90
5		.34	.54	.73	.86	.93
6		.44	.64	.80	.90	.96
7		.55	.73	.86	.94	.97
8		.65	.81	.91	.96	.98
9		.74	.87	.94	.97	.99
10		.81	.91	.96	.98	.99
11		.87	.94	.97	.99	.99

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